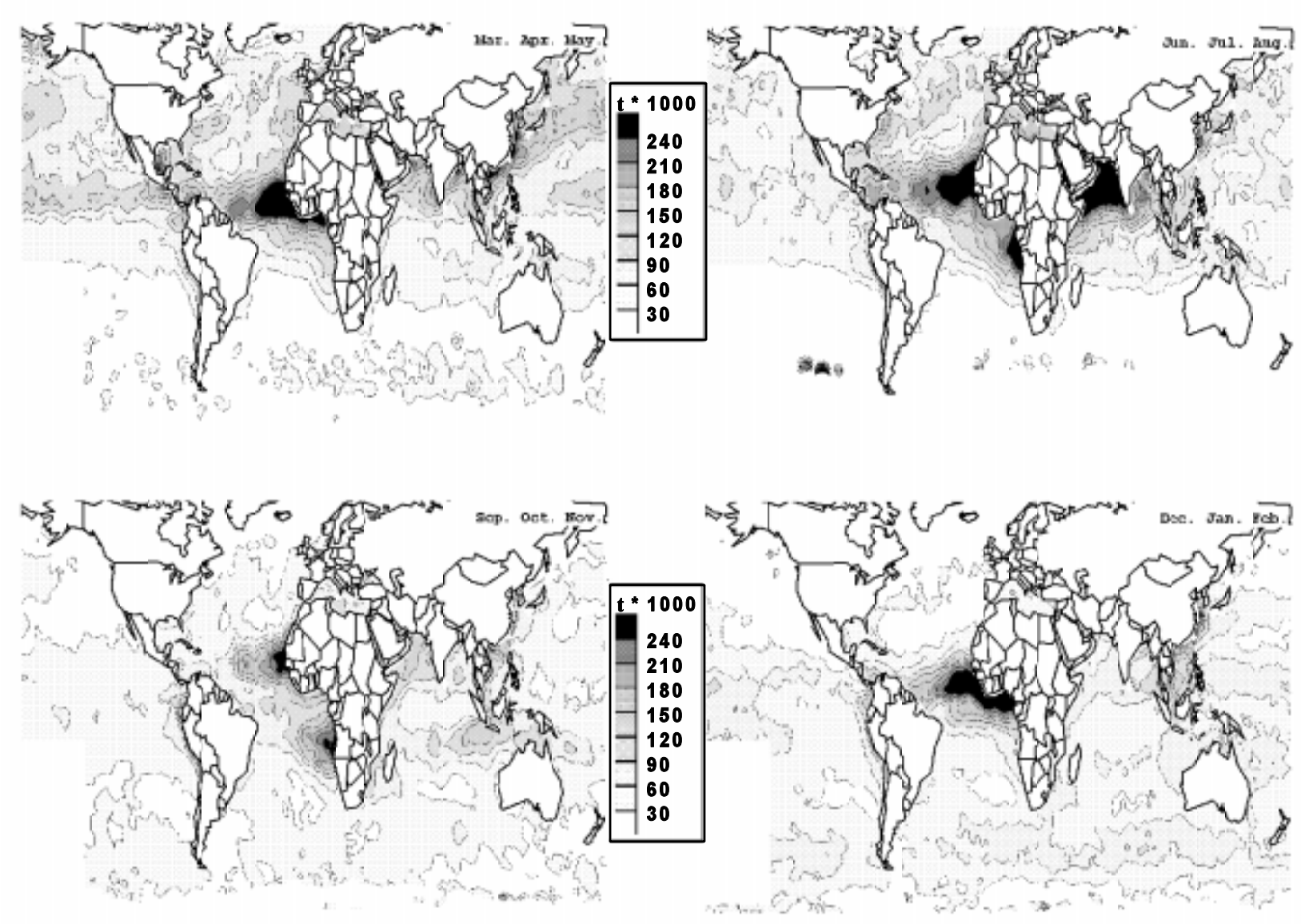

Figure 6-6. Global pattern of oceanic aerosols derived from satellite observations.

The continental aerosol extinction coefficient data for the southwest coast of North America indicate elevated aerosol extinction over southern California. The area includes the hazy South Coast and the San Joaquin Valley air basins. It is interesting to note that somewhat elevated aerosol optical thickness is also recorded over the Pacific near Southern California. However, the low aerosol signal and the semi-quantitative satellite data preclude a clear cause and effect association.

The seasonal aerosol pattern over the oceans reveals that the highest aerosol signal is found near the tropics, where wind-blown dust and biomass burning in Africa and southern Asia produce 5,000 km long aerosol plumes (Figure 6-6). Further aerosol belts which may be of marine origin are observed just north of the Equator and at 30 to 60° latitudes in both hemispheres. The backscattering in the summer hemispheres exceeds the winter values by a factor of 5 to 10. There is a pronounced seasonality in each aerosol region (Figure 6-7); the higher aerosol levels appear in the summer hemisphere although many continental and marine regions show a spring maximum. Thus, the global tropospheric aerosol is a dynamic collection of independent aerosol regions, each having unique sources and temporal patterns.

The seasonal oceanic aerosol maps show two distinctly different spatial patterns: aerosol plumes originating from continents, and oceanic aerosol patches that are detached from the continents. The continental aerosol plumes are characterized by high values near the coastal areas and a decline with distance from the coast. The most prominent aerosol plume is seen over the equatorial Atlantic, originating from West Africa and crossing the tropical Atlantic. It is the well known Sahara dust plume. Additional continental plumes emanate form Southwest Africa, Indonesia, China-Japan, Central America and eastern North America. Aerosols which may be of marine origin dominate large zonal belts (30 to 60° N and S) in the summer hemispheres as well as near the Equator. In summary, the global tropospheric aerosol is a collection of largely independent aerosol regions, each having a bio-geochemically active source and unique spatial temporal pattern.

Based on the above global and continental-scale observations, it can be concluded that the continental plume from eastern North America is not as intense as those from other industrial and non-industrial regions of the world. However, quantitative aerosol comparisons of global regions are not available.

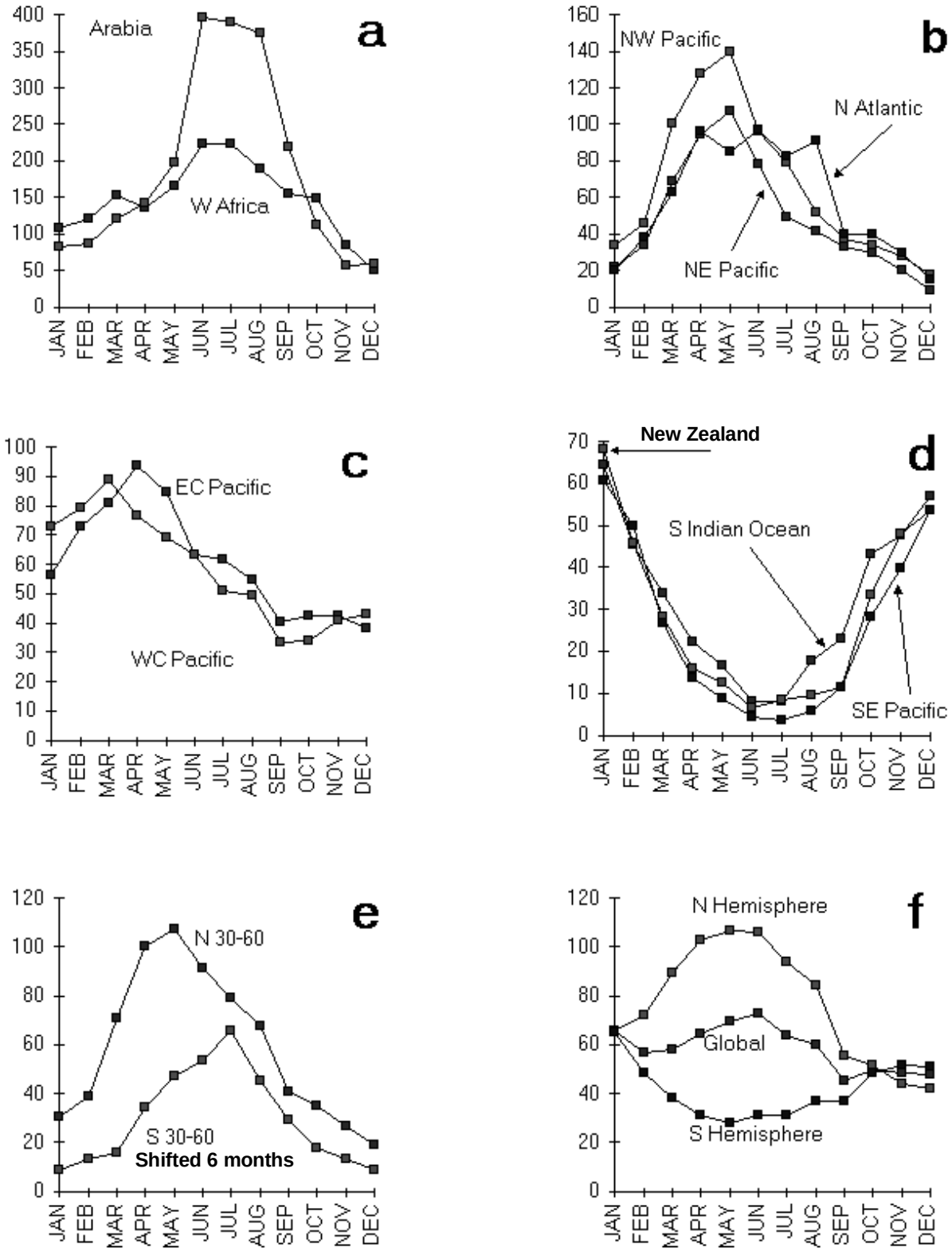

Figure 6-7. Seasonal pattern of oceanic aerosols derived from satellite observations.

6.3 U.S. NATIONAL AEROSOL PATTERN AND TRENDS

Our current understanding of the U.S. national aerosol pattern arises from nonurban, regional background monitoring networks, the Interagency Monitoring of Protected Visual Environments (IMPROVE) (Sisler et al., 1993) and the Northeast States for Coordinated Air Use Management (NESCAUM) (Poirot et al., 1990, 1991), and from a mainly urban network, the Aerometric Information Retrieval System (AIRS) (AIRS, 1995). The nonurban and urban networks yield markedly different national patterns, particularly over the western United States. For this reason the results from the two sets of observations are presented separately and the differences between two networks are evaluated. The data analyses presented here were performed for this Criteria Document and have not yet been published elsewhere.

6.3.1 Nonurban National Aerosol Pattern

Nonurban aerosol concentrations are measured at remote sites, away from urban-industrial activities. Size-segregated aerosol mass and chemical composition data are available for 50 sites, through the IMPROVE (Joseph et al., 1987; Eldred et al., 1987, 1988, 1990; Eldred and Cahill, 1994) and NESCAUM (Poirot et al., 1990, 1991; Flocchini et al., 1990) networks. These are located mostly in national parks and wilderness areas. The PM_{10} and $PM_{2.5}$ mass concentrations are sampled and analyzed on separate filters. The sampling frequency is generally twice a week (Wednesdays and Saturdays) for 24 hours. The $PM_{2.5}$ samples are analyzed for chemical composition which makes the data sets suitable for chemical mass balance computations (e.g., Sisler et al., 1993; Malm et al., 1994b). The IMPROVE/NESCAUM aerosol data are available from 1988 through 1993.

Measurements of PM are available from the IMPROVE/NESCAUM network at a smaller number of sites compared to the number of sites for which measurements are available from the AIRS network. The nonurban sites also have very different geographical distributions from those sites in the urban network. Therefore, the ability to compare PM_{10} concentrations from the nonurban and urban networks is severely limited by these factors.

The monthly distributions of chemical species, the chemical mass balances, obtained from the measurements at nonurban sites are incomplete. Only sulfate, organics, soil, and soot (elemental carbon) are considered. The contributions of hydrogen ion, water, trace metals and

sea salt are not listed. The contribution of nitrate is included on a national basis, but not in the subsequent discussion for regions.

The results of the national spatial and temporal pattern analysis are presented in quarterly contour maps and monthly seasonal time charts. The contours drawn for the eastern United States are derived from only 15 to 20 stations. As a consequence, these contour lines are to be taken as guides to the eye and not as actual patterns. The quarters of the year are calendrical.

6.3.1.1 Nonurban $PM_{2.5}$ Mass Concentrations

Maps of seasonal average nonurban $PM_{2.5}$ concentrations are shown in Figure 6-8. The maps divide the country roughly into eastern and western halves. The eastern United States is covered by large, contiguous $PM_{2.5}$ concentrations that range from 10 $\mu g/m^3$ in Quarter 1, and 17 $\mu g/m^3$ in Quarter 3. During the transition seasons (Quarters 2 and 4) the eastern U.S. nonurban $PM_{2.5}$ concentrations are at about 12 $\mu g/m^3$. Within the eastern U.S., there are subregions such as New England that have lower concentrations ranging between 8 and 12 $\mu g/m^3$. During the third quarter, there is a wider range of geographic distribution of $PM_{2.5}$ concentrations in the eastern United States than in other quarters of the year.

The lowest nonurban $PM_{2.5}$ concentrations are measured over the central mountainous western states. The low winter concentrations are at about 3 $\mu g/m^3$, while the summer values are around 6 $\mu g/m^3$. Somewhat elevated $PM_{2.5}$ concentrations are observed over the southwestern border adjacent to Mexico as well as in California and the Pacific Northwest. The nonurban fine particle mass clearly shows multiple aerosol regions over the conterminous U.S., each exhibiting unique spatial and seasonal characteristics.

6.3.1.2 Nonurban Particulate Matter Coarse Mass Concentrations

In classifying size fractions of PM, PM_{10} refers to PM collected in a sampler with a 50% cutpoint of 10 µm aerodynamic diameter and $PM_{2.5}$ to PM collected in a sampler with a cutpoint of 2.5 µm aerodynamic diameter. PMCoarse or coarse will be used to refer to the PM between the cutpoints of 2.5 and 10 µm, whether determined by subtracting a $PM_{2.5}$ sample mass from a PM_{10} sample mass or determined directly from the coarse particle channel of a dichotomous sampler with a PM_{10} (or PM_{15}) µm diameter upper cutpoint. Fine will also

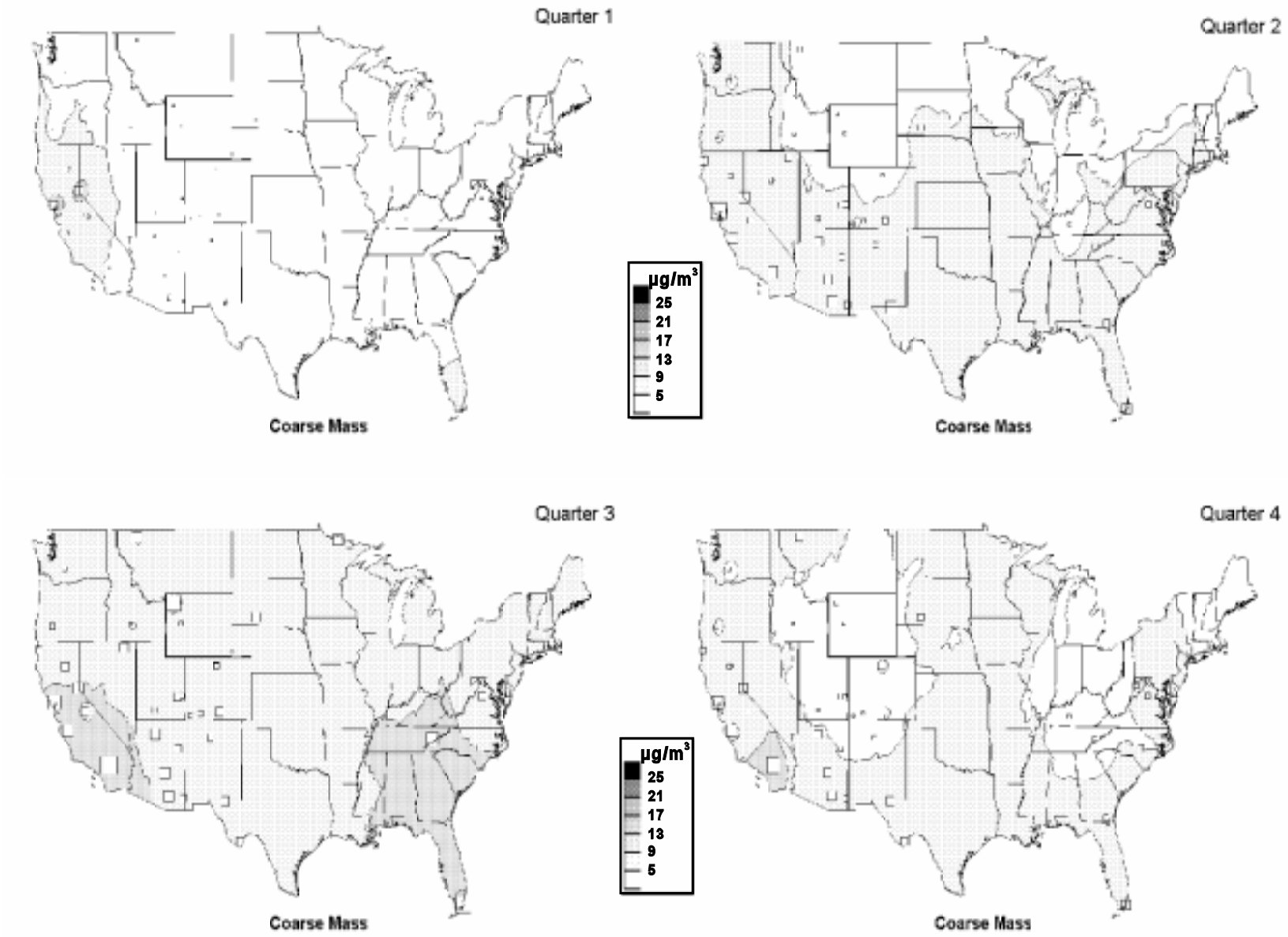

Figure 6-8. Coarse mass concentration derived from nonurban IMPROVE/NESCAUM networks.